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Helminths of the Western Toad, *Bufo boreas* (Bufonidae) from Southern California

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Abstract.—Museum specimens of *Bufo boreas* from southern California were examined for helminths. The helminth fauna consisted of one trematode species, *Haematoloechus kernensis,* one cestode species, *Distoichometra bufonis,* six nematode species, *Aplectana itzocanensis, Cosmocercoides variabilis, Falcaustra inglisi, Oswaldocruzia pipiens, Rhabdias americanus, Physaloptera* sp. (third stage larvae only). Helminths found in *B. boreas* are generalists occurring in other anuran species. *Bufo boreas* represents a new host record for *H. kernensis, A. itzocanensis, F. inglisi,* and *Physaloptera* sp. (larvae).

The western toad, *Bufo boreas* Baird and Girard 1852, occurs from southern Alaska to northern Baja California, from the Pacific Coast to the Rocky Mountains and from sea level to over 3600 m (Stebbins 1985). There are five previous reports of helminths in *B. boreas:* California (Ingles 1936; Walton 1941; Koller and Gaudin 1977), Idaho (Waitz 1961), and Utah (Frandsen and Grundmann 1960). The purpose of this study is to present additional helminth records for *B. boreas* from southern California.

Sixty-nine *B. boreas* from the herpetology collection of the Natural History Museum of Los Angeles County (LACM) were examined: Los Angeles County (N = 30, collected 1958, 1972, mean snout-vent length [SVL] = 73.4 mm ± 14.8 SD, range 37–95 mm, LACM 115185–115208, 144207–144208, 144210–144213); Orange County (N = 3, collected 1972, SVL = 84.7 mm ± 7.2 SD, range 80–93 mm, LACM 144209, 144214–144215); Riverside County (N = 11, collected 1958–1959, 1964, 1966–1967, SVL = 82.0 mm ± 10.1 SD, range 64–102 mm, LACM 11218, 11220–11221, 11223, 87313–87316, 87323, 87325, 87327); San Bernadino County (N = 25, collected 1955, SVL = 67.2 mm ± 9.3 SD, range 47–81 mm, LACM 11297–11300, 11302, 11305–11307, 11309–11315, 11318, 11343–11344, 11351–11352, 11355–11357, 11359, 11362).

Toads had been fixed in 10% formalin and preserved in 70% ethanol. The body cavity was opened by a longitudinal incision from throat to vent and the digestive tract (esophagus, stomach, small and large intestine), lungs and urinary bladder were removed and examined for helminths with a dissecting microscope. The liver and body cavity were also searched for helminths. Helminths were intitially examined using the standard glycerol wet-mount procedure. Nematodes were identified from these wet mounts. Trematodes and cestodes were stained in hematoxylin, dehydrated in increasing concentrations of ethanol, cleared in xylene and mounted in balsam for identification. Terminology is in accordance with Bush et al. (1997).

The helminth fauna of *B. boreas* examined in this study consisted of one species of Trematoda, *Haematoloechus kernensis* Ingles 1932; one species of Cestoda, *Distoichometra bufonis* Dickey 1921; and six species of Nematoda, *Aplectana itzocanensis* Bravo Hollis 1943, *Cosmocercoides variabilis* (Harwood 1930), *Falcaustra inglisi* (Anderson 1964), *Oswaldocruzia pipiens* Walton 1929, *Rhabdias americanus* Baker 1978 and *Physaloptera* sp (third-stage larvae only). Selected helminths were placed in vials of 70% ethanol and deposited in the U.S. National Parasite Collection (USNPC), Beltsville, Maryland as: *Haematoloechus kernensis* (88065); *Distoichometra bufonis* (88066); *Aplectana itzocanensis* (88067); *Cosmocercoides variabilis* (88068); *Falcaustra inglisi* (88069); *Oswaldocruzia pipiens* (88070); *Rhabdias americanus* (88071); *Physaloptera* sp., third stage larvae (88072).

Prevalence and mean abundance ± SD by county are presented in Table 1. *Aplectana itzocanensis* occurred in the small and large intestines; *O. pipiens* was found in the stomach and small and large intestines. Other helminths were site specific: *D. bufonis,* small intestine; *H. kernensis* and *R. americanus,* lungs; *C. variabilis* and *F. inglisi,* large intestines; *Physaloptera* sp. stomach.

None of the helminths found in this study is unique to *B. boreas.* These helminths are generalists which occur in other anurans. *Haematoloechus kernensis* is known previously only from its type host, *Rana aurora,* from California (Ingles 1932). Two of the six North American species of *Haematoloechus* exhibit short extracaecal uterine loops but can be separated on the shape and location of the testes: *H. kernensis* with round almost parallel testes; *H. varioplexis* with elongate oblique testes (Kennedy 1981). *Bufo boreas* represents a new host record for *H. kernensis.*

The monotypic *D. bufonis* is known throughout western North America from species of *Hyla, Bufo, Scaphiopus* and *Spea* (see Douglas 1958; Goldberg and Bursey 1991a,b; Goldberg et al. 1995). Koller and Gaudin (1977) reported *Distoichometra* sp. from *B. boreas* collected in Los Angeles County. Thus, this is the second report of this cestode from southern California from *B. boreas.*

Aplectana itzocanensis is known from species of *Bufo, Gastrophryne, Scaphiopus* and *Spea* from Costa Rica, México and the southwestern United States (Goldberg et al. 1998). The two North American species, *A. incerta* and *A. itzocanensis* are separated on the basis of the number of eggs in gravid females: *A. incerta* with approximately 50 eggs; *A. itzocanensis* with several hundred eggs (Baker 1985). *Bufo boreas* represents a new host record for *A. itzocanensis.*

Cosmocercoides variabilis has been reported from North American salamanders, frogs, lizards, snakes and turtles (see Baker 1987). Some uncertainty exists for its hosts because of confusion between *C. variabilis* and *Cosmocercoides dukae,* a molluscan parasite. Vanderburgh and Anderson (1987) demonstrated that the two species are distinct. The major difference in morphology for the two species is the number of rosette papillae in the male: *C. dukae* with 12 pairs, *C. variabilis* with 14 to 20 pairs. Ingles (1936) reported *C. dukae* from *Taricha torosa*, *Rana aurora* and *B. boreas* from California but illustrated 16 pairs of papillae and for this reason we refer his specimens to *C. variabilis.* We also refer the *Cosmocercoides* sp. of Koller and Gaudin (1977) to *C. variabilis.* Thus, this is the third report of *C. variabilis* from *B. boreas.*

Falcaustra inglisi has been reported from *Rana catesbeiana, Rana clamitans*

Table 1. Helminths from 69 *Bufo boreas* from southern California.

Helminth	Los Angeles County (N = 30)		Orange County (N = 3)		Riverside County (N = 11)		San Bernardino County (N = 25)	
	Prevalence[1] (%)	Mean abundance[2] ± SD	Prevalence (%)	Mean abundance (±SD)	Prevalence (%)	Mean abundance ±SD	Prevalence (%)	Mean abundance ±SD
Trematoda								
Haematoloechus kernensis[3]	—	—	—	—	—	—	28	4.32 ± 9.28
Cestoda								
Distoichometra bufonis	3	0.17 ± 0.91	—	—	—	—	12	0.12 ± 0.33
Nematoda								
Aplectana itzocanensis[3]	—	—	33	0.67 ± 1.15	18	7.55 ± 17.21	16	1.08 ± 2.69
Cosmocercoides variabilis	—	—	—	—	18	1.73 ± 4.15	—	—
Falcaustra inglisi[3]	3	0.03 ± 0.18	—	—	—	—	—	—
Oswaldocruzia pipiens	33	1.87 ± 3.67	—	—	9	0.18 ± 0.60	—	—
Rhabdias americanus	—	—	—	—	—	—	32	1.00 ± 1.87
Physaloptera sp.[3]	—	—	33	2.00 ± 3.46	—	—	—	—

[1] Number of toads infected with one or more individuals of a parasite species divided by the number of toads examined.
[2] Total number of individuals of a parasite species divided by the total number of toads examined.
[3] = new host record.

Table 2. Helminth parasites of *Bufo boreas.*

Helminth	Locality	Prevalence (%)	Reference
Trematoda			
Glypthelmins shastai	California	not given	Ingles 1936
	California	2/115 (2)	Koller and Gaudin 1977
Gorgoderina sp.	California	not given	Ingles 1936
Gorgoderina translucida	Idaho	1/8 (13)	Waitz 1961
Haematoloechus kernensis	California	7/69 (10)	this study
Megalodiscus microphagus	California	not given	Ingles 1936
Phyllodistomum bufonis	Utah	not given	Frandsen and Grundmann 1960
Cestoda			
Distoichometra bufonis	California	19/140 (14)	Koller and Gaudin 1977
	California	4/69 (6)	this study
Nematoda			
Aplectana itzocanensis	California	7/69 (10)	this study
Cosmocercoides variabilis	California	not given	Ingles 1936
	California	40/255 (16)	Koller and Gaudin 1977
	California	2/69 (3)	this study
	Utah	not given	Frandsen and Grundmann 1960
Falcaustra inglisi	California	1/69 (1)	this study
Falcustra pretiosa	California	not given	Walton 1941
Megalobatrachonema gigantica	Utah	not given	Frandsen and Grundmann 1960
Oswaldocruzia pipiens	California	not given	Ingles 1936
	California	119/255 (47)	Koller and Gaudin 1977
	California	11/69 (16)	this study
Rhabdias americanus	California	not given	Ingles 1936
	California	13/255 (5)	Koller and Gaudin 1977
	California	8/69 (12)	this study
Physaloptera sp. (larvae)	California	1/69 (1)	this study

and *Rana septentrionalis* from Ontario, Canada (Baker 1987). The nine North American species of *Falcaustra* (see Baker 1987) are separated by size of spicule and position of caudal papillae. *Falcaustra inglisi* is the only species having 2 pairs of large and 2 pairs of small precloacal papillae. *Bufo boreas* represents a new host record and California a new location record for *F. inglisi.*

All North American specimens of *Oswaldocruzia* have been referred to *O. pipiens* by Baker (1977). This species is widely distributed in North America and has been reported from frogs, toads, salamanders, lizards and tortoises (see Baker 1987). *Oswaldocruzia* sp. was reported from *B. boreas* in California by Koller and Gaudin (1977). This is the second report of *O. pipiens* from *B. boreas.*

Rhabdias americanus was first described from *Bufo americanus* collected in Canada (Baker 1978) and has been reported from species of *Bufo* from the southwestern United States (see Goldberg et al. 1996). In addition, Baker (1978) referred reports of *Rhabdias bufonis* in *Bufo woodhousii* and *Bufo americanus* of eastern North America to *R. americanus.* We refer the reports of *Rhabdias* sp. in *B. boreas* from California (Ingles 1936; Koller and Gaudin 1977) to *R. americanus* because Ingles (1936) in his survey of amphibian parasites reported this *Rhabdias* to be a species other than *Rhabdias joaquinensis* or *Rhabdias ranae;*

R. americanus was not described until 1978 (Baker 1978). This is the third report of *R. americanus* from *B. boreas.*

Third stage larvae of *Physaloptera* sp. are common in toads, but no parasitism by adult physalopterans in toads has been reported (Goldberg et al. 1995). *Bufo boreas* represents a new host record for larvae of *Physaloptera* sp.

Reasons for the patchy distribution of helminths found in this study (Table 1) are unknown. No helminth species occurred in all locations; yet, given general distribution ranges, each helminth species might be expected to be present. Koller and Gaudin (1977) also report similar differences in helminth species distribution for two populations of *B. boreas* from southern California. Likewise, other helminths have been reported from populations of *B. boreas* in California (Table 2), but were not found in this study.

Of the parasites listed in Table 2, the trematodes require an aquatic intermediate host (Smyth and Smyth 1980); the life cycle of the cestode *D. bufonis* is unknown (Hardin and Janovy 1988). With the exception of *Physaloptera* which has an indirect life cycle requiring an insect intermediate host, the nematodes are acquired orally or by skin penetration (direct life cycles) and have moisture sensitive larval stages (Anderson 1992). In either case, indirect or direct life cycle, environmental conditions have a deciding role in patchy distribution patterns by causing local changes in the distribution of intermediate hosts or the hydrologic cycle while not affecting the historical pattern of host distribution. More work will be required to determine the factors responsible for the patchy distribution patterns of parasites within this host; specifically, annual prevalence studies with environmental monitoring for several populations of B. boreas should be initiated.

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